Clean Coal Power Initiative

CCPI Planning Workshop

September 28, 2001

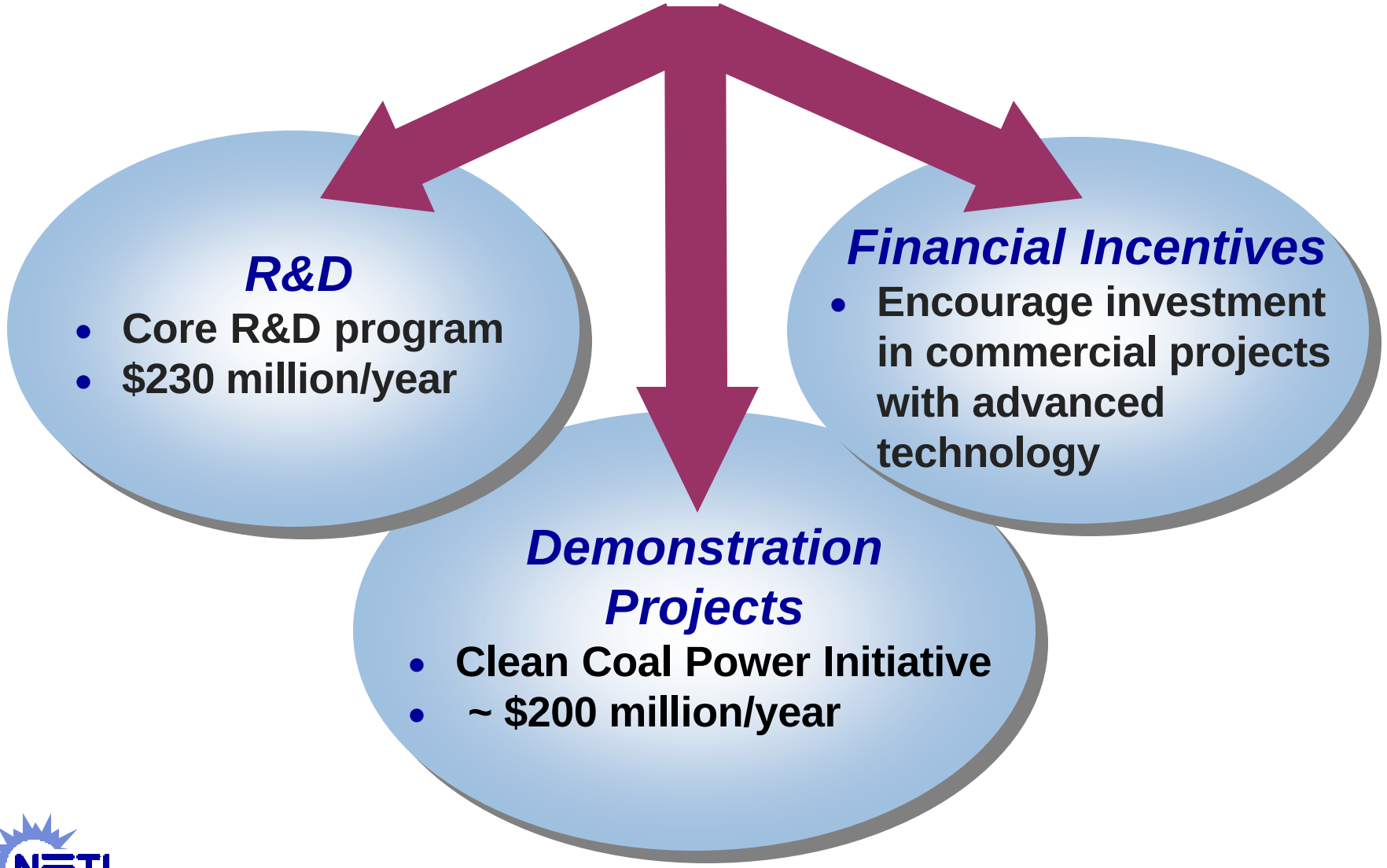
Rita A. Bajura, Director

National Energy Technology Laboratory

www.netl.doe.gov

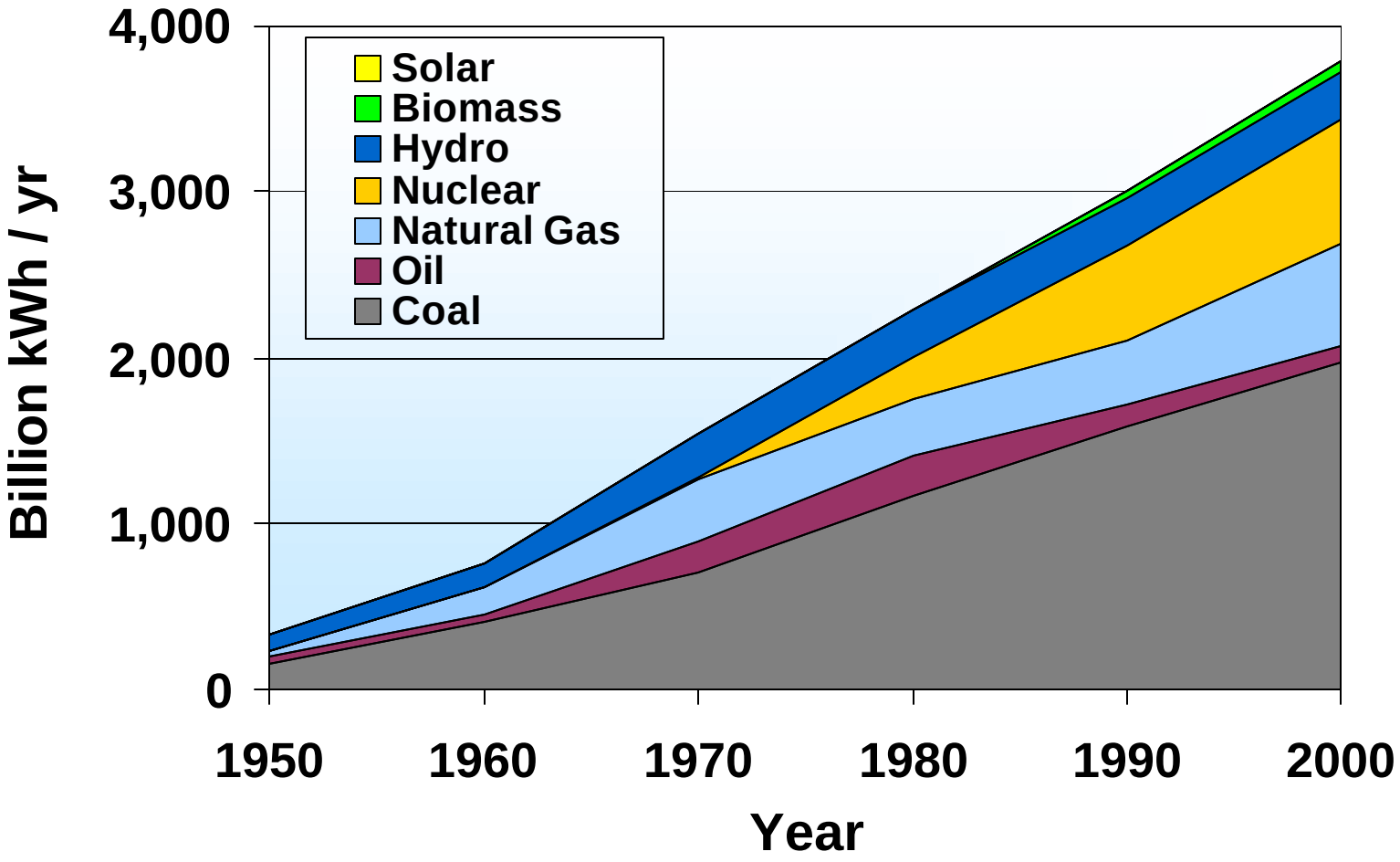
Clean electricity from coal is key component of National Energy Policy

Government's Coal Investment Strategy

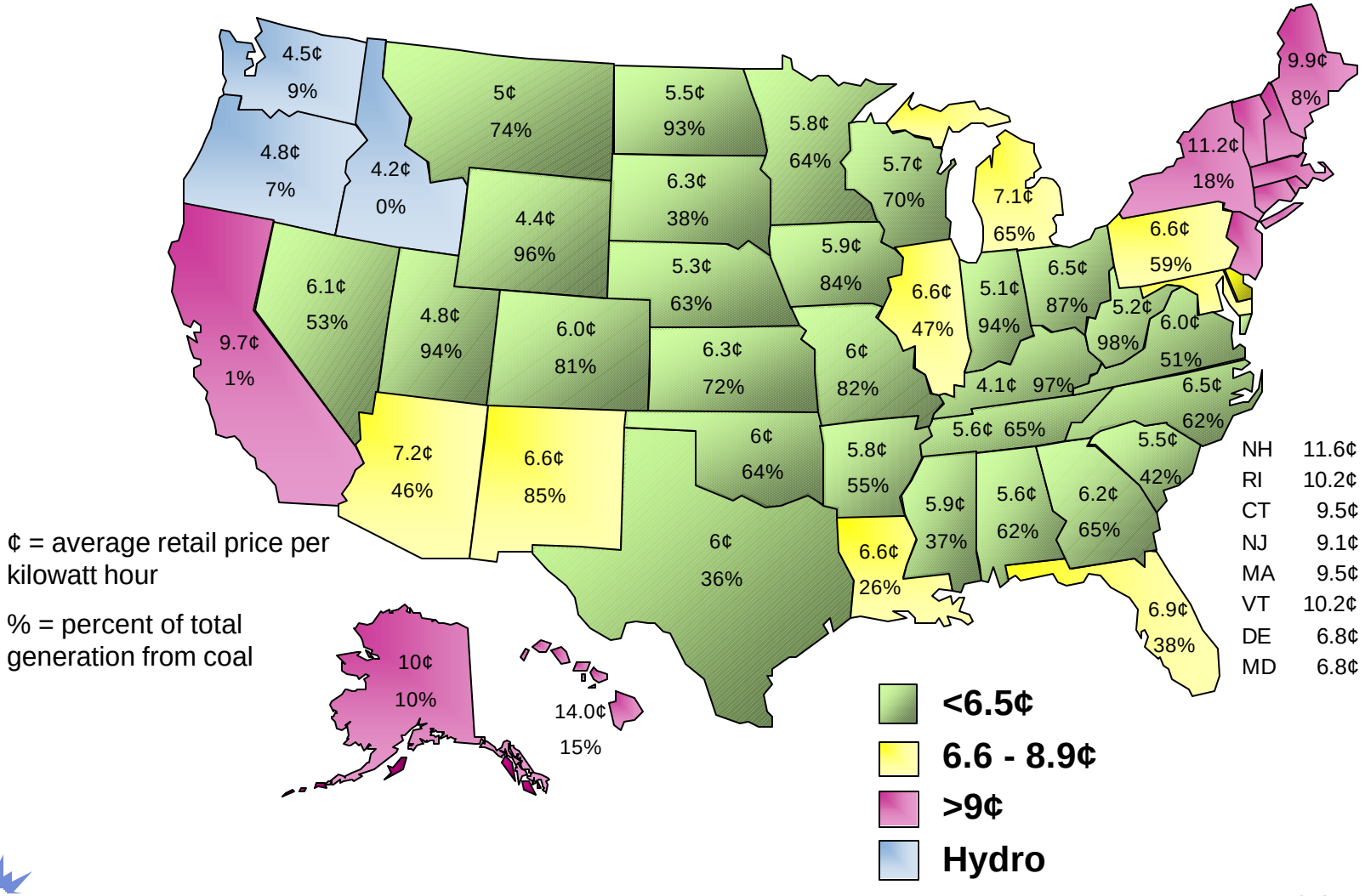


U.S. Electric Generation

Coal Provides 52% of U.S. Electricity



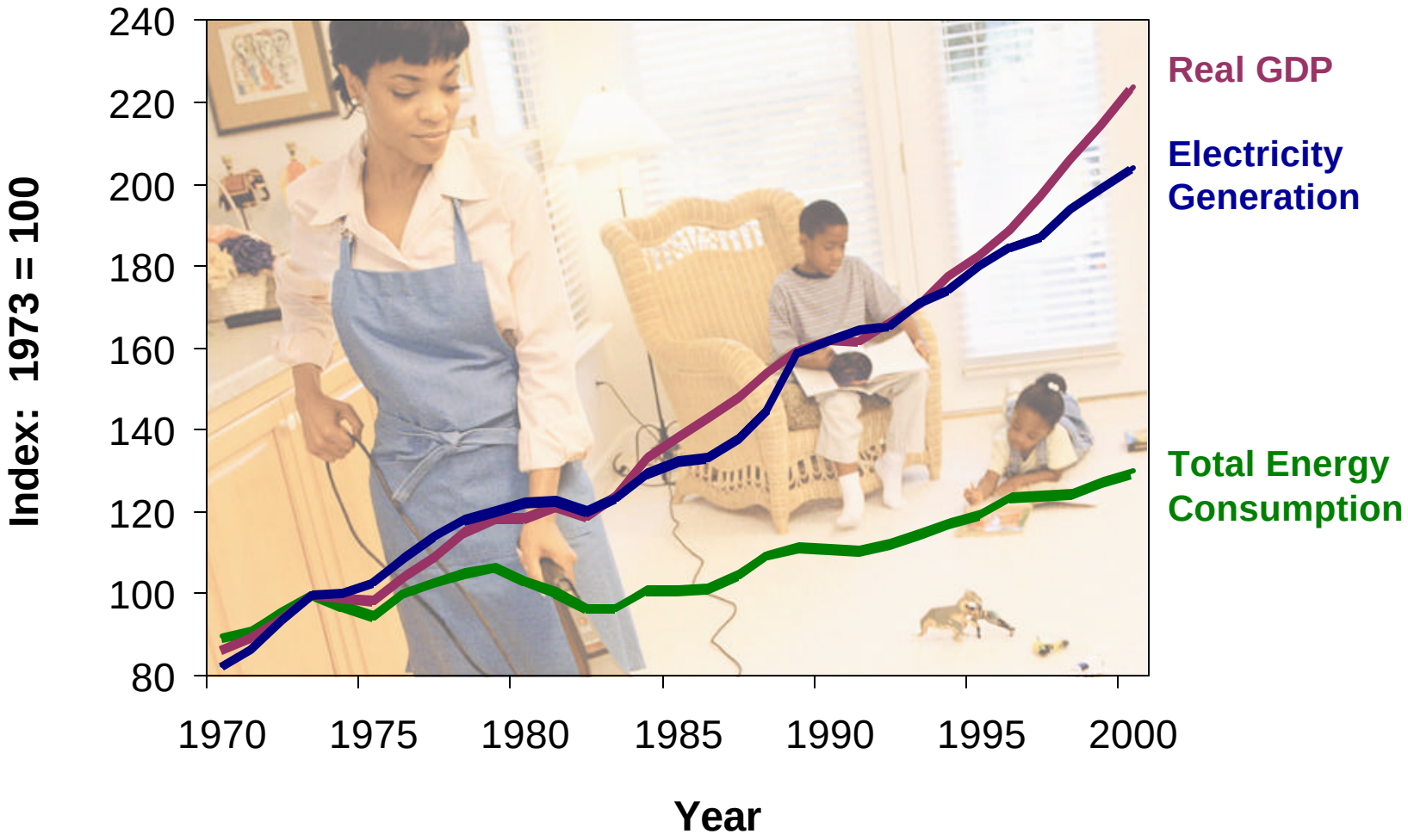
Coal Use Translates to Reliable, Affordable Electricity



NH	11.6¢	26%
RI	10.2¢	0%
CT	9.5¢	11%
NJ	9.1¢	17%
MA	9.5¢	30%
VT	10.2¢	0%
DE	6.8¢	69%
MD	6.8¢	56%

Peabody Coal/DOE/EIA

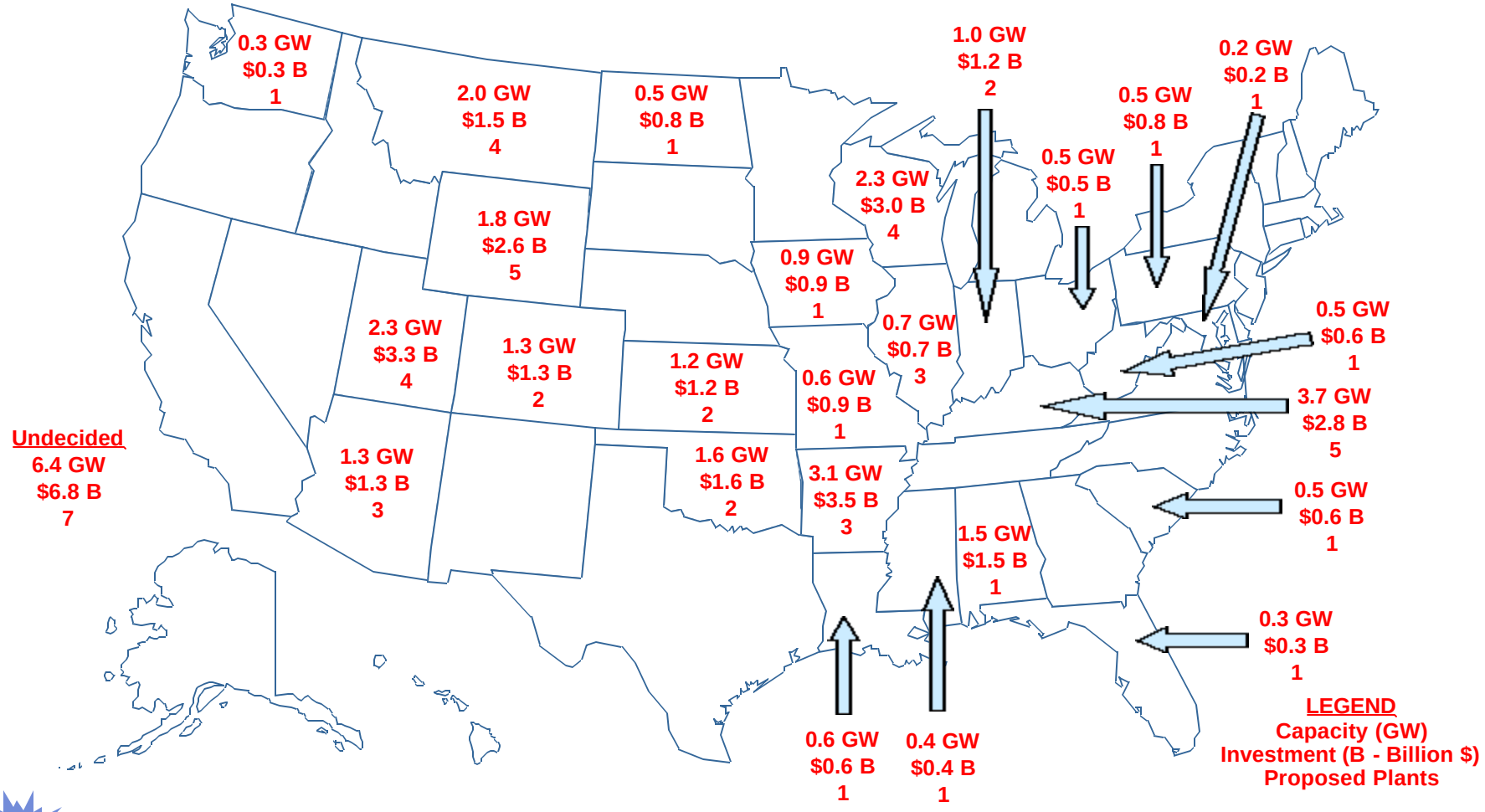
Economic Growth Linked to Electricity



GDP: U.S. DOC, Bureau of Economic Analysis
Energy & Electricity: EIA, AER Interactive Data Query System

Many New Coal Plants Announced

59 Plants & 36 GW Proposed at $39 Billion Investment

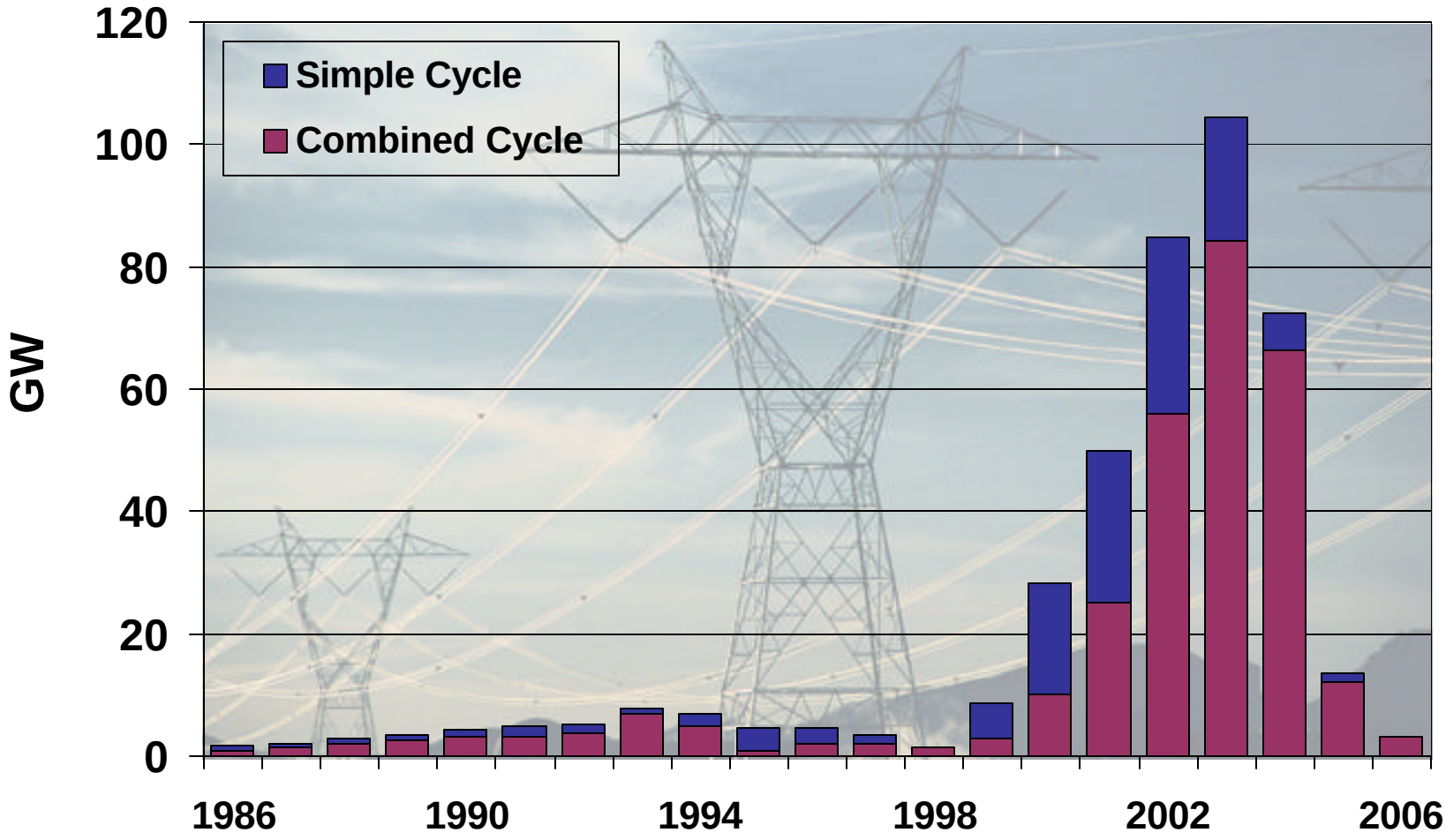


NETL

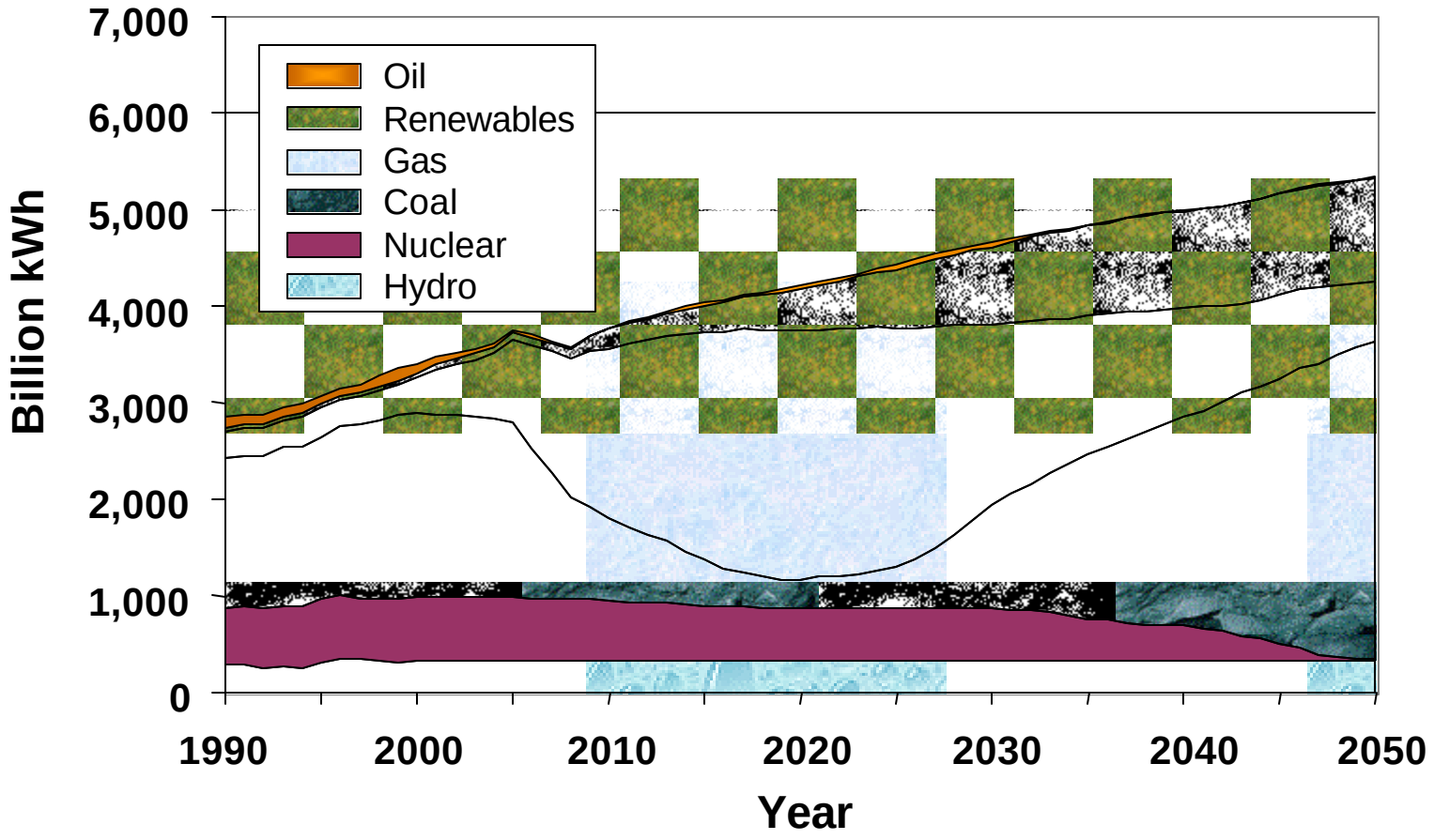
NETL New Coal Capacity Database

Gas-Fired Capacity Additions

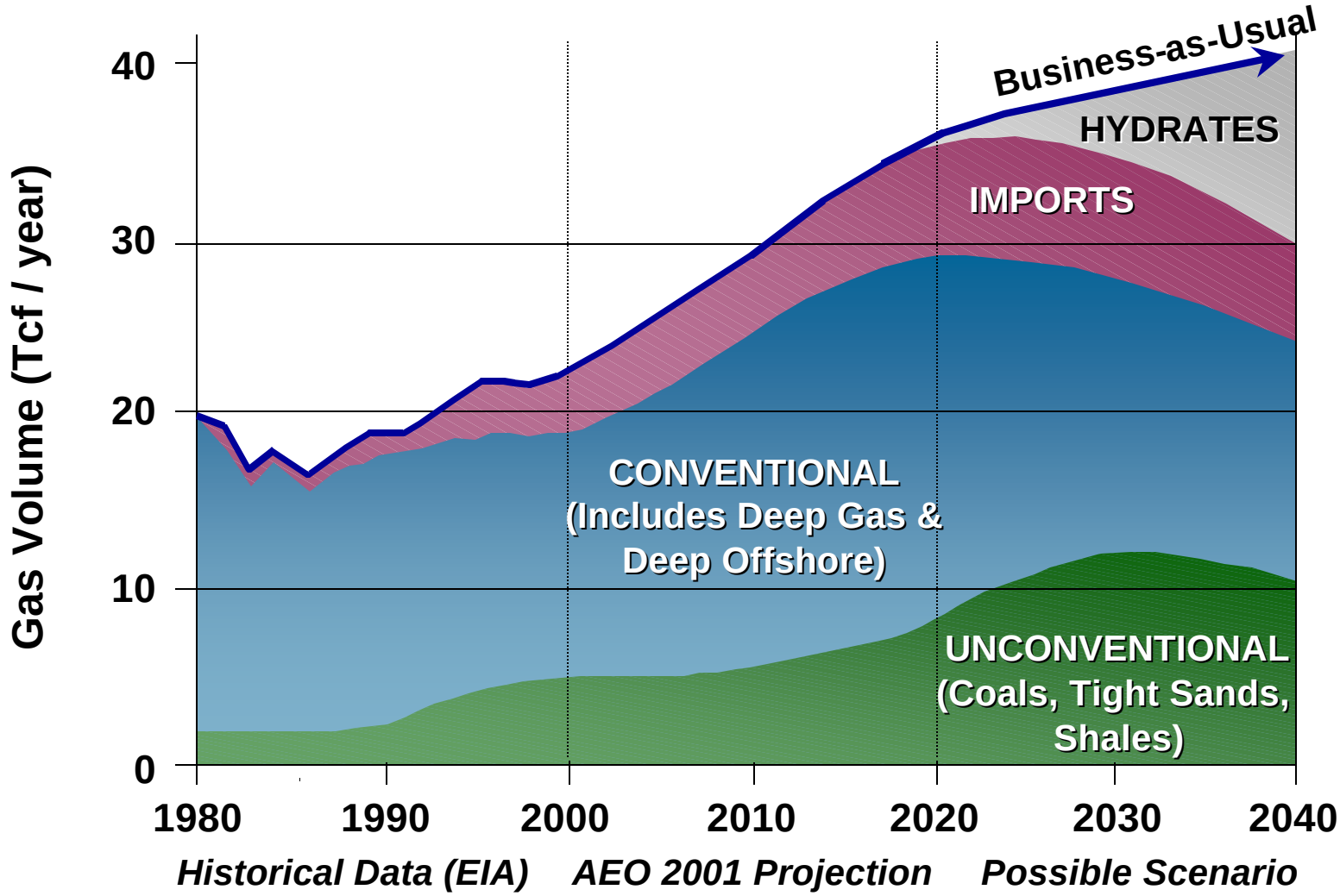
Historical and Projected - 3rd Quarter, 2001



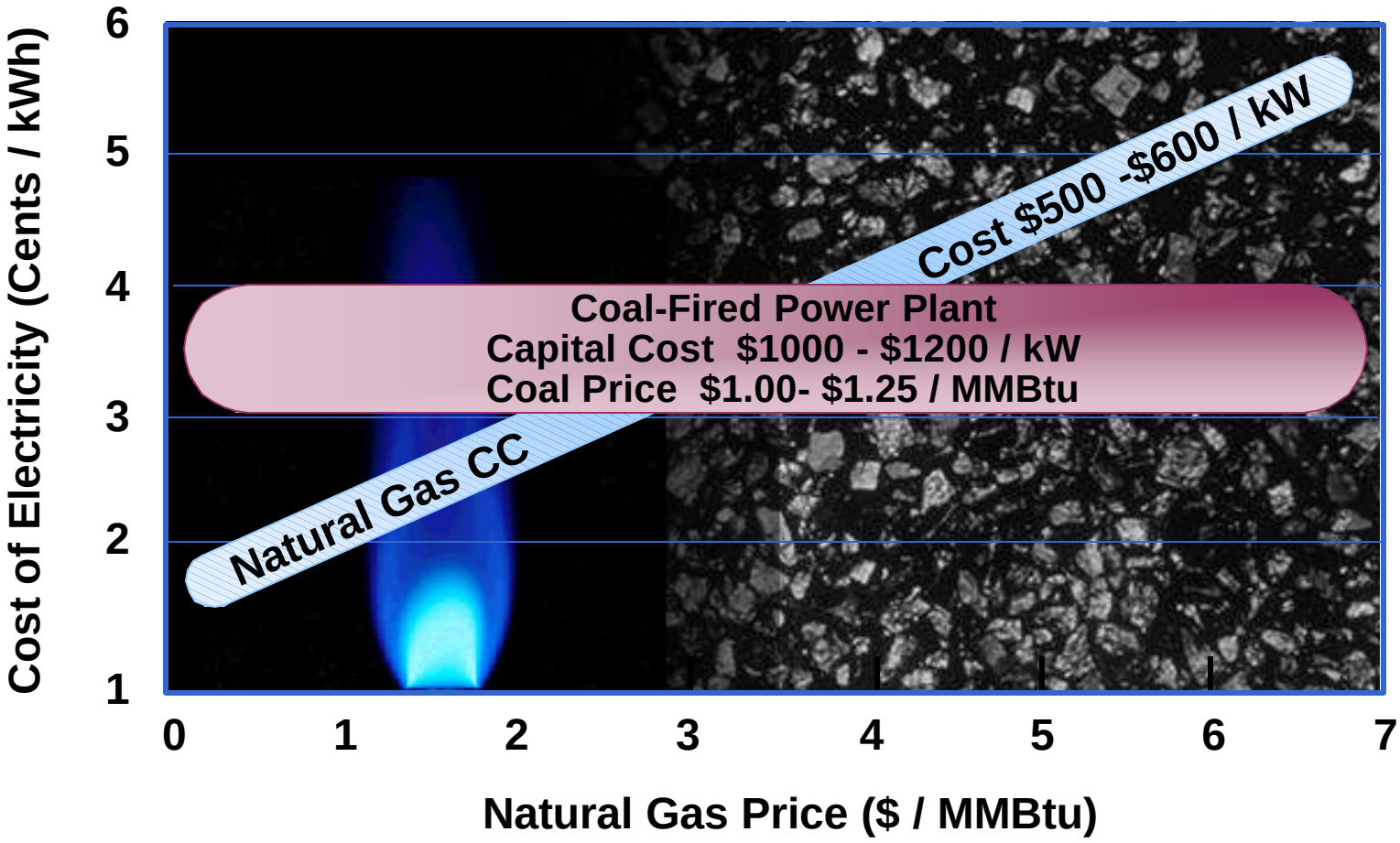
A Scenario for U.S. Electric Generation
1990-2050



Enough Affordable Gas to Meet Demand?

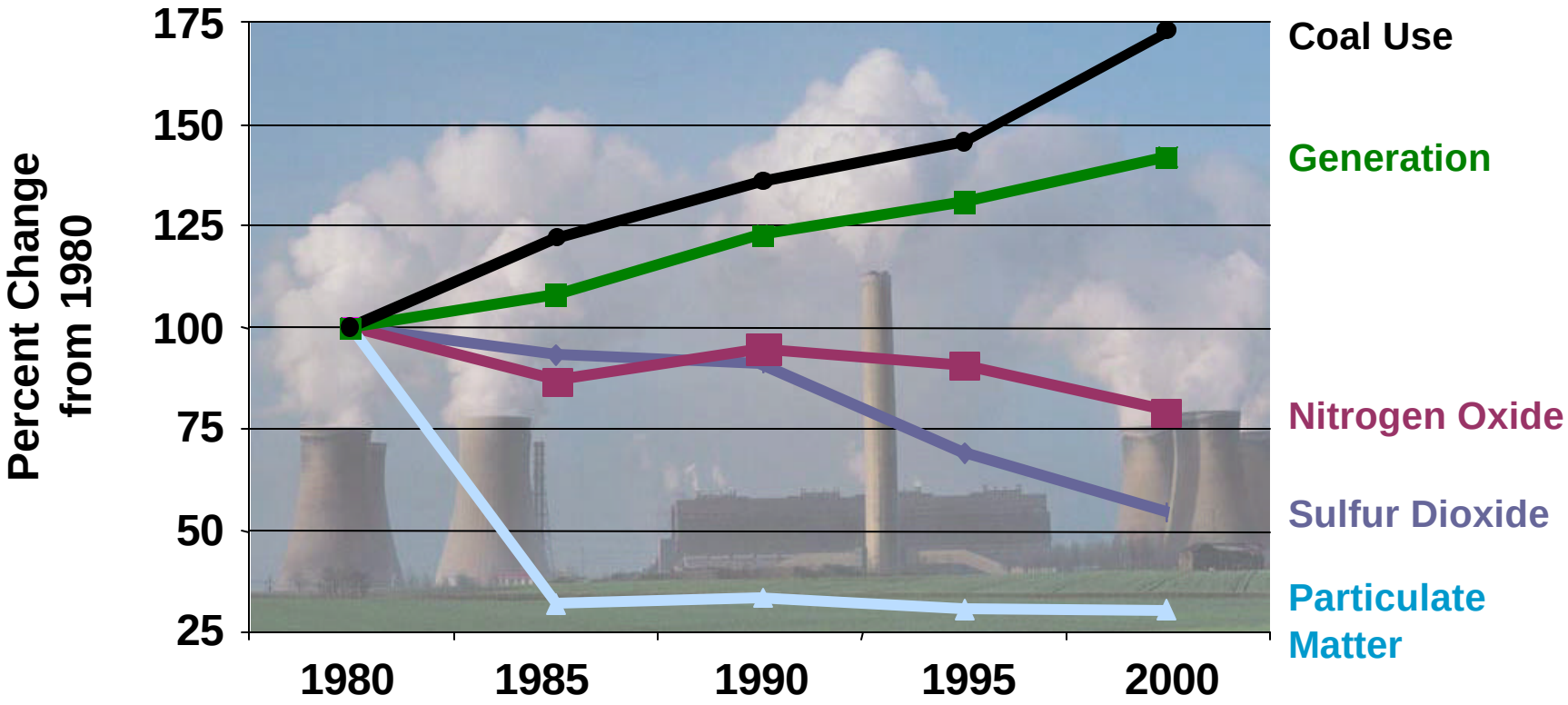


New Coal Marginally Competitive with Gas



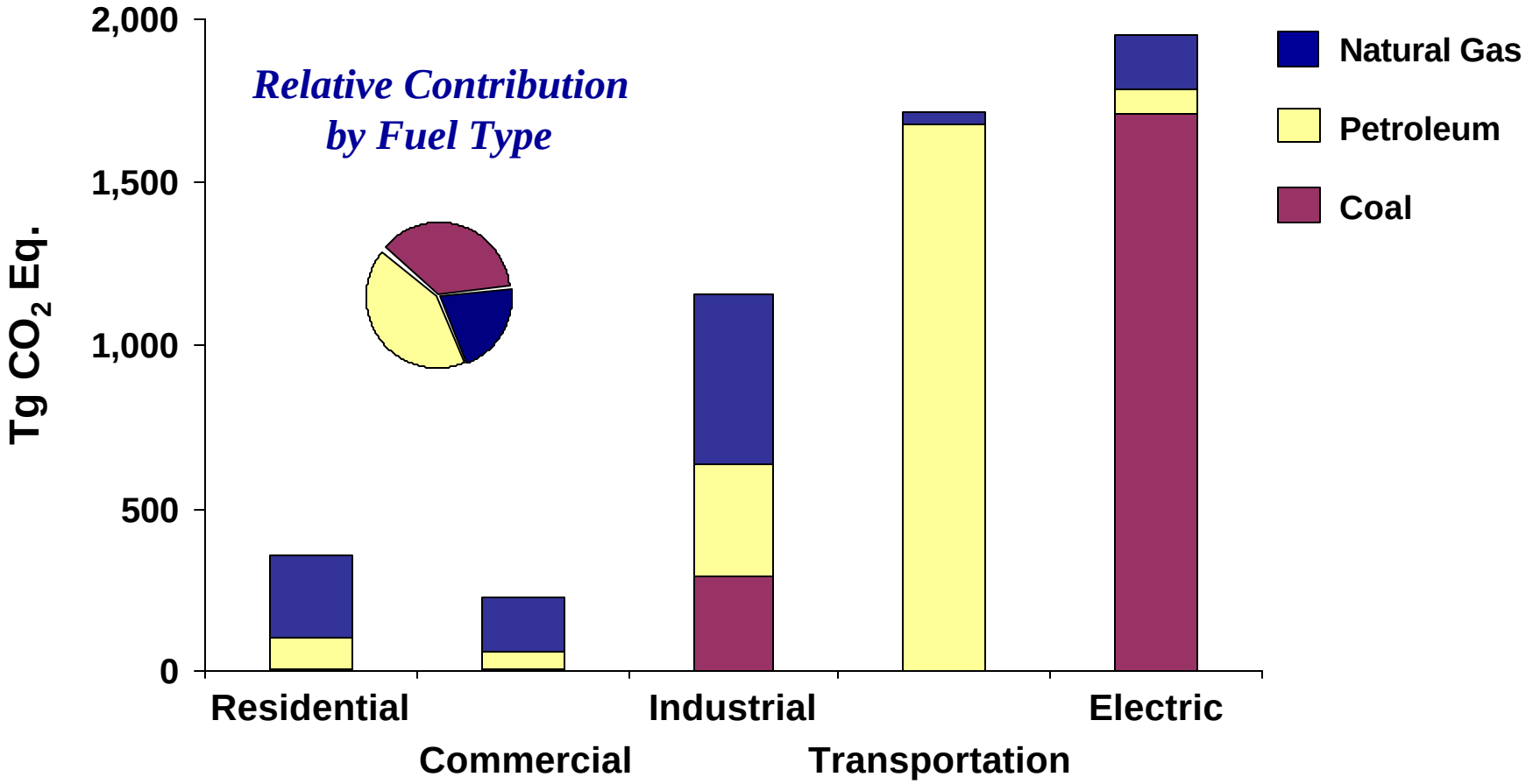
Criteria Pollutants Down

Progress in Meeting Environmental Goals



Electricity Sector Produces 1/3 CO_2

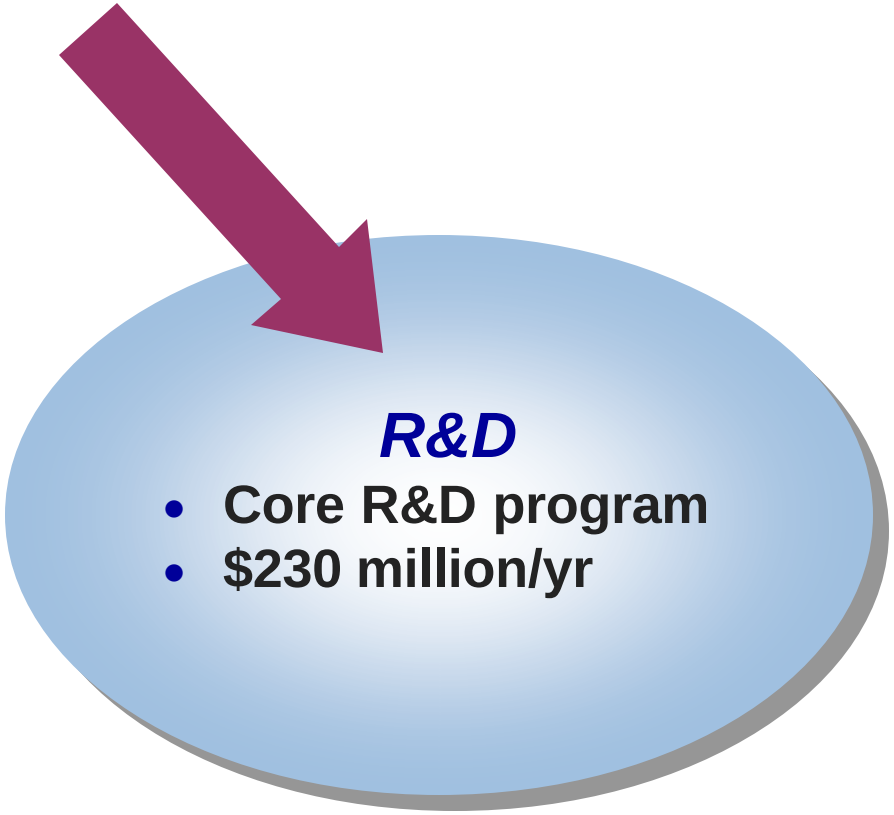
1999 CO_2 Emissions from Fossil Fuel Combustion



Note: Electric utilities also includes emissions of 0.04 Tg CO_2 Eq. from geothermal-based electricity generation

Table 2-3, EPA 236-R-01-001, April 2001
Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-1999

Government's Coal Investment Strategy



Environmental Control
Existing Fleet of Coal Plants

- **Technology to meet regulatory schedules**
- **Data to assure science-based regulations**

Activities

- **Ultra-low NO_x**
- **Mercury**
- **$PM_{2.5}$**
- **Acid gases**
- **Multi-contaminants**
- **CCBs**

ADA-ES Sorbent Injection Meeting
Southern Company Gaston Station
April 2001

- ***Jim Kilgroe - EPA***
- ***Scott Renninger - DOE/NETL***
- ***George Offen - EPRI***

Combustion Systems

- Develop low cost, high efficiency new systems
- Improve current fleet efficiency and reliability

Activities

- PSDF
- HT particulate filters
- LEBS 80-MW demo
- Ultra-supercritical materials
- Capitol Power Plant design

Advanced Materials Consortium
Ultra-Supercritical Power Plants
CURC/EPRI/ ORNL/NETL

Gasification Systems

Improved Gasification and Cleanup Processes

Efficiency

- **Cost**
- **Sequestration compatibility**

Activities

- **PSDF**
- **O_2, H_2, CO_2 separation**
- **Co-production design optimization**
- **Improved refractory**

Tampa Electric Co. IGCC
Polk Power Station

Vision 21
Ultra-Clean Energy Plant of Future

Energy Plants for Post-2015

- **Use available feeds**
  - Coal, gas, biomass, waste
- **Electricity primary product**
  - May co-produce fuels, chemicals, steam, heat

Goal

Absolutely Minimize Environmental Implications of Fossil Energy Use

Approach

- **Maximize efficiency**
  - 60% coal-to-electric
- **Near-zero emissions**
  - Option for carbon sequestration

Fuels

- **Multiple product systems**
  - Early entrance coproduction
  - High value products
- **Future fuels**
  - H2
  - Super clean liquids

Environmental

- **Produce and deliver cleaner fuels**

Energy Security

- **Enable use of all domestic energy resources**

Carbon Sequestration

Capture and Storage

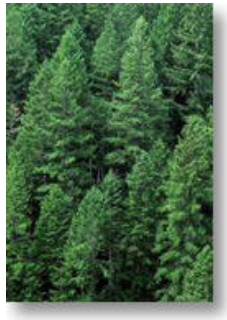
Unmineable Coal Seams

Deep Ocean Injection

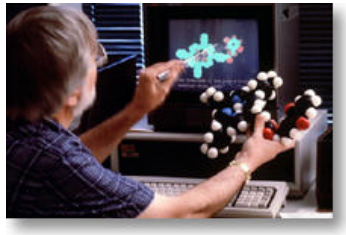
Depleted Oil / Gas Wells, Saline Reservoirs

Enhance Natural Processes

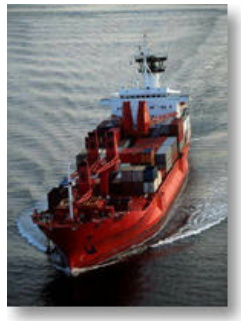
Mineral Carbonation



Forestation



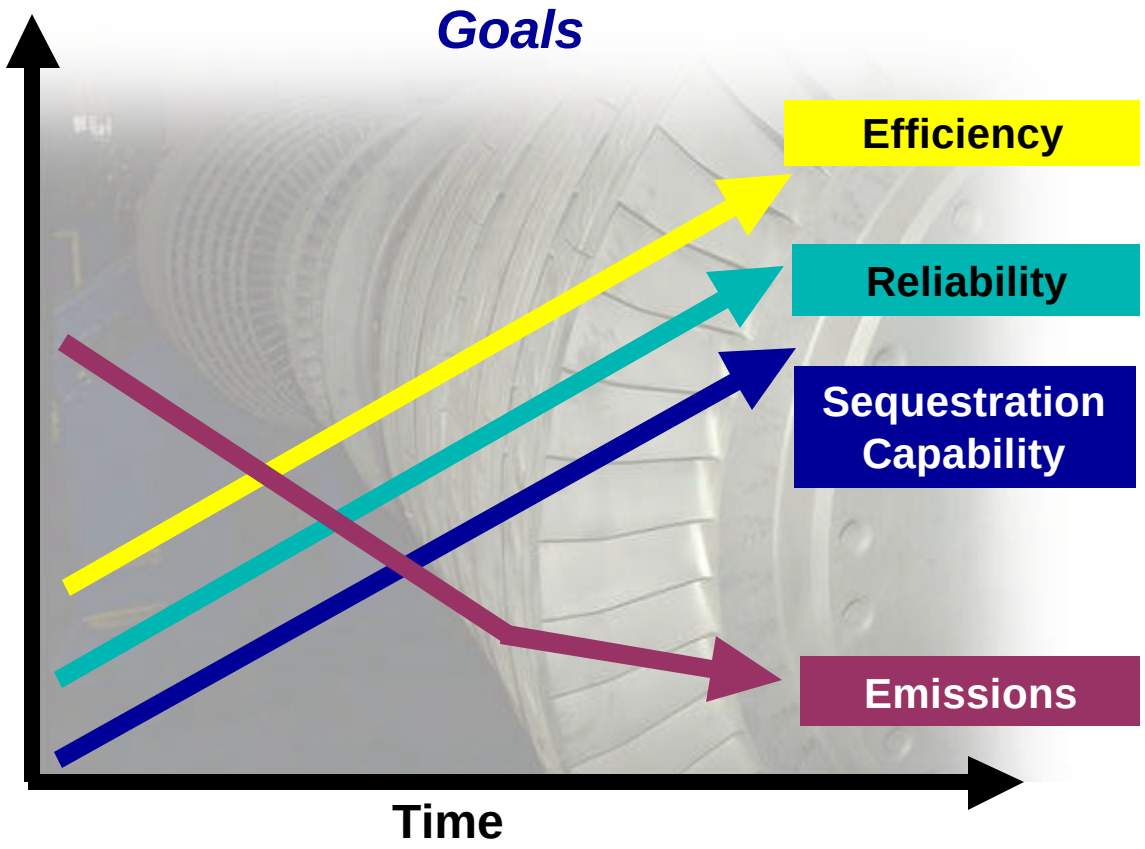
Enhanced Photosynthesis



Iron or Nitrogen Fertilization of Ocean

- Provide technology options that address CO_2 stabilization
- Achieve target cost of $10 / ton of carbon removed

Combustion Turbines



Enabling Technologies

- **Advanced materials**
- **Heat transfer and aerodynamics**
- **Combustion**
  - Coal gas capability
- **Sensors and controls**

No Increase in Life Cycle Costs

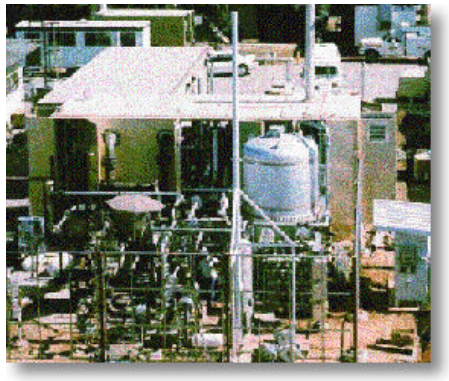
Stationary Fuel Cells
Route to Triple the Efficiency of Power Generation

- **Small units gas fueled**
- **Coal gas in future large units**
- **Hybrids route to lower cost/higher efficiency**

S-W SOFC

McDERMOTT NEXTECH MATERIALS Honeywell DELPHI TMI SYSTEMS SIEMENS Westinghouse Battelle Cummins Power Generation

Solid State Energy Conversion Alliance



FCE MCFC

NETL

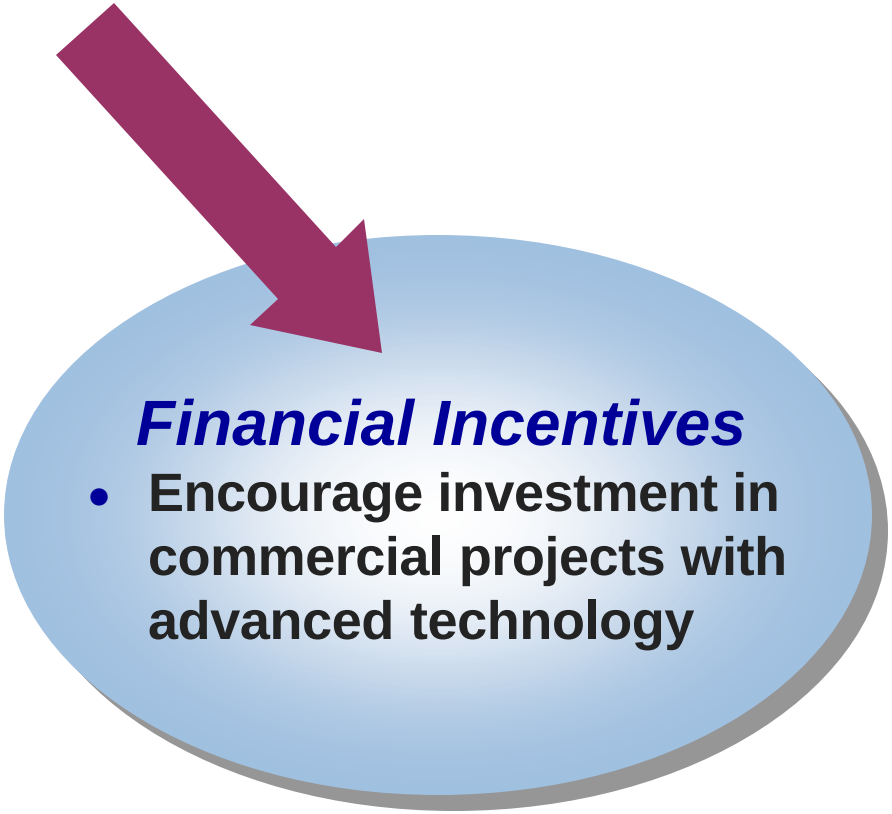
Advanced Research

- **Explore innovations**
- **Crosscutting science and technology**

Activities

- **Materials**
- **Simulation & modeling**
- **Biotechnology**

Government's Coal Investment Strategy

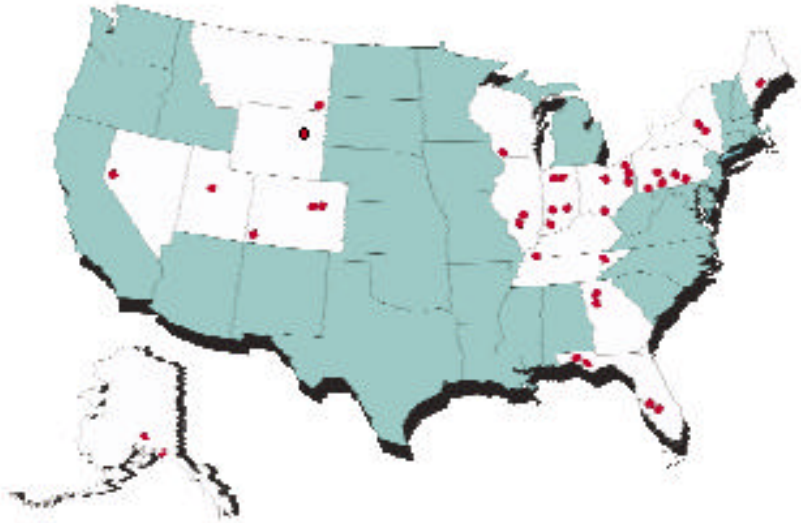


Government's Coal Investment Strategy

Clean Coal Scorecard

✓ Commercial Successes to Date

(Domestic or international sales made, or technology continues to operate commercially at plant site)



1986-93 Clean Coal Technology Project Selections

38 Projects - 18 States
$1.7 Billion - Federal Gov't
$3.5 Billion - Private Industry/States
$5.2 Billion - Total Cost

$100 BILLION - CUMULATIVE BENEFITS

	Project	Company	Location
✓	Gas Suspension Absorption	AirPol	W. Paducah, KY
	Confined Zone Dispersion	Bechtel	Seward, PA
✓	LIFAC Sorbent Injection	LIFAC	Richmond, IN
✓	Adv. Flue Gas Desulfurization	Pure Air	Chesterton, IN
✓	CT-121 Flue Gas Scrubber	So. Co. Services	Newnan, GA
✓	NOx Control - Wall-Fired	So. Co. Services	Coosa, GA
	Coal Reburning	B&W Co.	Cassville, WI
✓	Low-NOx Cell Burner	B&W Co.	Aberdeen, OH
✓	Gas Reburning/Low-NOx Burn.	EERC	Denver, CO
	Micronized Coal Reburning	NYSEG	Lansing, NY
✓	Selective Catalytic Reduction	So. Co. Services	Pensacola, FL
✓	NOx Control - T-Fired	So. Co. Services	Lynn Haven, FL
✓	SNOX Flue Gas Cleaning	ABB	Niles, OH
✓	LIMB SO2/NOx Control	B&W Co.	Lorain, OH
	SOx-NOx-ROx Box	B&W Co.	Dilles Bottom,OH
	Gas Reburning/Sorbent Inj.	EERC	Two sites - IL
✓	Milliken Clean Coal Project	NYSEG	Lansing, NY
✓	Dry NOx/SOx Control Sys.	Pub. Service CO	Denver, CO
	McIntosh PFBC Project (4A)	City of Lakeland	Lakeland, FL
	McIntosh PFBC Project (4B)	City of Lakeland	Lakeland, FL
	JEA Fluidized Bed Project	JEA	Jacksonville, FL
✓	Tidd PFBC Project	Ohio Power Co.	Brilliant, OH
✓	Nucla CFB Project	Tri-State	Nucla, CO
	Kentucky Pioneer Project	Kentucky Pioneer	Trapp, KY
	Pinon Pine Power Project	Sierra Pacific	Reno, NV
✓	Tampa Electric IGCC Project	Tampa Electric	Mulberry, FL
✓	Wabash River Repowering	Dynegy/PSI	W.Terre Haute, IN
	Clean Coal Diesel	AD Little	Fairbanks, AK
	Healy Clean Coal Project	AIDEA	Healy, AK
✓	Liquid Phase Methanol	Air Products	Kingsport, TN
✓	Adv. Coal Conversion	Western Syncoal	Colstrip, MT
✓	Coal Quality Expert	CQ Inc. & ABB	Multiple Sites
✓	ENCOAL Mild Gasification	ENCOAL Corp.	Gillette, WY
	Integrated Coal/Ore Reduction	CPICOR	Vineyard, UT
	Pulse Combustor	MTCI	Baltimore, MD
✓	Blast Furnace Injection Sys.	Bethlehem Steel	Burns Harbor, IN
	Cyclone Combustor	Coal Tech Corp	Williamsport, PA
	Cement Kiln Scrubber	Passamaquoddy	Thomaston, ME

NETL

Power Plant Improvement Initiative

- **Congressionally mandated demonstration program in FY 2001**
- **Selection announcements soon**

Purpose of Today's Workshop
Power Plant Improvement Initiative

Engage potential partners and other stakeholders to address key questions

- **What technologies should be addressed in RD&D program?**
- **What draws industry to be involved in demos and deployments?**
- **What regulatory/policy barriers constrain deployments?**
- **What management structure will maximize benefits to nation?**

Four Breakout Sessions

Session #1

Technology

What Technologies Should Be Addressed in RD&D Programs?

- Technology response to market drivers
- Infrastructure improvements
- Establishing a technology portfolio
- Technology management

Session #2

Markets & Business

What Draws Industry to Demos;
What Does It Take to Get a Technology Broadly Deployed?

- Risk and incentives
- Repayment
- Teaming
- Financing options for demos
- Industry participation

Session #3

Regulatory

How Do Regulations Drive and Constrain RD&D and Deployments?

- Public needs & benefits
- Regulatory constraints
- Control technology (e.g., mercury)
- Byproduct management
- Water usage
- Emissions trading
- Stability and certainty
- Priorities or key issues for CCPI

SCR technology at TVA Paradise Plant

Session #4

Management

What Management Structure Will Maximize Benefits to Nation?

- Industry & association involvement guideline development
- Program implementation & management approaches
- Priorities or key issues for CCPI

A Possible CCPI Funding Profile
$ Millions

	FY02	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	Total
Round I	$150									$150
Round II		$150	$200[A]							$350
Round III				$250	$250[A]					$500
Round IV						$250	$250[A]			$500
Round V								$250	$250[A]	$500
Total	$150	$150	$200	$250	$250	$250	$250	$250	$250	$2000

A = Advanced Appropriations

Industry Participated in CCT Program!

The participants

- **> 55 individual electric generators**
  - Serve in 33 states
  - Operate > 178 GWe
  - Produce ~ 1/4 U.S. electricity
  - Consume ~ 1/3 U.S. coal production
- **> 50 technology supplies**
- **30 engineering, construction, consulting companies**

Industry and Government Working Together Have Done Great Things!

- Low-NO_X burners now on 75% of U.S. capacity
- SCR to reduce NO_X now half original cost; orders for 30% of U.S. capacity
- Scrubbers now 1/3 cost of ’70s vintage; more than 400 commercially deployed
- Thorough database on power plant mercury emission levels and controls
- New, high-strength alloys for power plants
- Development of FBCs – combustion “success story” of the 1970s-80s
- Introduction of IGCC– with unparalleled efficiency gains and super-clean performance
- Breakthrough in gas turbine technology with 60% efficient systems and NO_X emissions cut in half

Continued decline in air emissions and greenhouse gases without adding cost burdens to economic growth

Defining Technology Path to U.S. Electricity Future

Your Help Is Needed

The Future